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The Length of Working Life of Males in Great Britain

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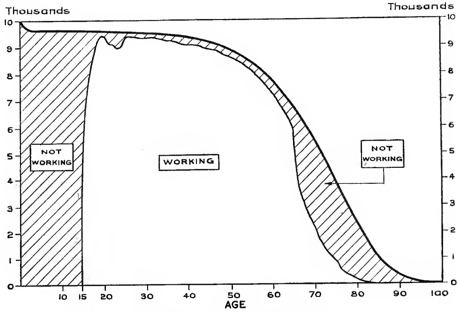

1955 Working-life Table: Survivors out of 10,000 males born

Numbers still living and numbers in the working population at various ages (stationary population)

I. Introduction

TABLES showing the "probability of survival" have long been in use, particularly in connection with the determination of life insurance premiums and annuity rates. They are, in effect, a device for setting out, in a concise form, the death rates experienced by a particular community during a specified period. They are designed in such a way as to give answers to such questions as "What are the chances that a man aged 30 will die before reaching the age of 40" or alternatively "What are the chances that such a man will survive to age 40." The life table also provides an answer to the question "What is the average number of years of life remaining to those of a given age." A complete life table gives information for males and females separately for each integral year of age. Abridged life tables are also compiled giving the same information for ages at quinquennial or decennial intervals. In all life tables the only factor taken into account is mortality; it is assumed that there is no migration into or out of the group of persons to which a table relates.

2. When using a life table it is important to remember that the table does not show what will in fact happen in the future. The table is based on the mortality experience of a past period and it shows what would happen in the future only on the assumption that past mortality experience continues unchanged. As changes are bound to occur the assumption is tenable only for estimating the general course of events. It is therefore more usual nowadays to regard the life table as no more than a convenient way of presenting in a summarized form information about mortality experience in a given period.

3. If all males above a certain age entered the working population and remained in work until they died the life table for males could be used to answer questions about expectation of remaining in the working population similar to the questions mentioned above relating to years of life. There has, however, never been this exact identity between the expectation of life and the expectation of remaining in the working population. Owing to sickness, infirmity and old age there must always have been a number of men who were unable to work, and since the beginning of this century social legislation has made it possible for an increasing number of persons to spend a significant number of years in retirement. There is accordingly a substantial difference at particular years of age between the average expectation of life and the average expectation of remaining in the working population and their associated probabilities of survival, and it is therefore desirable if possible to compile separate tables to show the expectation of working life. Such a table for Great Britain as a whole and based on information for individual years of age has now been prepared in respect of males in 1955, together with a corresponding table for 1931(1). The method of compiling the table is described in the following paragraphs.

4. The table of working life is in fact an extension of the normal life table. It is drawn up in such a way as to give answers to such questions as "What are the chances that a man aged 30 will still be in the working population at age 40", or alternatively "What are the chances that such a man will leave the working population before reaching the age of 40". The table also provides an answer to the question "What is the expected average number of years of working life remaining to those of a given age". As with the life table, the table of working life is based on the mortality experience of a past period, but it also reflects the losses through causes other than death of a past period. The table therefore shows what will happen in the future if these rates of losses remain unchanged.

5. The calculation of a working-life table raises difficulties additional to those inherent in deriving a life table. The figures for individual years of age, both for the total population and for the working population, are not known precisely and they have had to be estimated from the information that is available (i.e., figures for five-year groups for the total population and figures based largely on a 1 per cent. sample for the working population). The margins of error in this basic material will also be reflected in the series of figures showing the proportions in the working population at each year of age. (*See* para. 6 of Technical Appendix). It must also be remembered that retirement, unlike death, is not clear-cut. It is not always possible to be sure that a person recorded as retired has in fact left the working population. Many persons who work on their own account never really retire although the amount of time they devote to their businesses declines steadily with advancing age.

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(1) Tables of this type, but limited to selected occupational groups, have long been in use by Actuaries (under the title of "Service Tables") in connection with the valuation of occupational pension schemes. See the Paper "On the Valuation of Staff Pension Funds" by H. W. Manly and E. C. Thomas in the *Journal of the Institute of Actuaries* for 1902. Tables of working life on a national basis have been prepared and published by the United States Bureau of Labour Statistics (Bulletin No 1001 August, 1950) and by the Department of Statistics of New Zealand (*Tables of Working Life 1951*, Wellington 1957). The preparation of the table of working life for Great Britain has benefited considerably from the earlier work undertaken by these two countries. It should be observed however that the working-life table for Great Britain differs in a number of respects from both the American and the New Zealand tables. Owing to differences in the basic statistical material used and to other differences, great care must be exercised in any attempt to compare the working-life table for Great Britain with the working-life tables for the United States of America and New Zealand. In particular, account must be taken of differences in the relative numbers in different industries and occupations.

II. Method of compiling a Table of Working Life for Males

(a) THE LIFE TABLE

6. The basic figure in a life table is a hypothetical group of 10,000 persons assumed to be born at the same time. This is followed by an estimate of the number surviving at the first birthday on the assumption that the group is subject to the same mortality experience in the first year of age as that shown by the actual "vital statistics" for a recent period. A similar estimate is made for each subsequent year of age until the last surviving member of the group finally disappears at 101 years of age or thereabouts. A series of figures for males in Great Britain based on the Registrar-General's abridged life-table for 1952–1954 was supplied by the Government Actuary and is given in Column 3 of Table 1. This series is denoted by the symbol l_x.

7. For the purpose of estimating the number of years of life remaining to the survivors at any age it is necessary first of all to establish the aggregate number of man-years that they will live. The actuarial practice is to assume that deaths are evenly spread over the year and that the number of man-years lived between two consecutive birthdays by persons who were alive at the beginning of that year can therefore be estimated by averaging the numbers alive at the two birthdays. The procedure accordingly is to establish a new column of figures by averaging each pair of consecutive figures in Column 3. These are set out in Column 4 and are designated by the symbol L_x.

8. The sum of all the figures in Column 4 represents the total number of man-years lived, from their fifteenth birthday onwards, by the survivors of the original 10,000. In the same way the sum of the figures in that column for any age-interval and all higher age-intervals represents the number of man-years of life remaining to persons who were alive at the beginning of that age interval (i.e. l_x for that particular age); in other words the remaining number of man-years that this number of persons may expect to live. If this number of man-years is divided by the number of persons l_x, the answer is the "average expectation of life" for persons of that age.

9. The cumulative total number of man-years from any age-interval onwards is designated by the symbol T_x and the figures on this basis for each year of age are shown in Column 5 in Table 1. The "average expectation of life" is designated by the symbol $\mathring{e}_x$, and the figures are given in Column 6 in the Table.

(b) THE WORKING-LIFE TABLE

10. The fact that detailed age-analyses of the total population and of the working population are available from Census and other sources makes it possible to compute tables showing the expectation of *working* life in the same form as the tables showing the expectation of life. The first step is to compute, for each year of age, the percentage that the working population represents of the total population. For Census years both sets of figures can be taken from the Census tables. For other years an age-analysis of the total male population can be based on the annual estimates in broad age-groups, made by the Registrar-General, and corresponding figures of the working population can be based largely on the annual estimates made by the Ministry of Labour and National Service on the basis of counts of national insurance cards. On the basis of this information estimates were made of the percentage of males occupied at each exact year of age in 1955. These are given in Column 2 of Table 1 under the symbol w_x. It is assumed that the period of working life begins at age 15, but although the majority of boys leave school at this age and immediately enter the labour force an increasing number spend further years at Universities and other institutions of advanced education. The result is that the proportion in the working population steadily increases till it reaches a maximum somewhere in the 25–30 age class. The complication that would be involved in taking account of entry into the working population at these earlier years has been avoided by adopting the maximum proportion in the working population for each of those years. This means, in effect, that for those years of age the proportion is to be interpreted as "the proportion who have entered or are in training for employment".

11. Since each figure in Column 3 (l_x) represents the number of men alive at that exact year of age, and the figure w_x in Column 2 on the same line is the proportion that the working population represents of the total population of the same age, it follows that if the two figures are multiplied together the result will represent the estimated number at each exact year of age in the working population out of the original 10,000. A series of figures obtained in this way is set out in Column 7 of Table 1 under the symbol l_x^w.

12. The next step is to compute the series of figures given in Column 8 of Table 1 (L_x^w). These have been obtained from the l_x^w column in the same way that the L_x figures (Column 4) were derived from the l_x figures (Column 3)(2). The sum of all the figures in Column 8 represents the total number of man-years spent in the working population from their 15th birthday onwards by

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(2) With the exception of the figure for age 65. See the Appendix, para. 11.

the survivors of the original 10,000. In the same way the sum of the figures in that column for any age-interval and all higher age-intervals represents the number of man-years of working life remaining to persons who were in the working population at the beginning of that age-interval (i.e. l_x^w for that particular age); in other words, the remaining number of man-years that this number of persons may expect to spend in the working population. If this number of man-years is divided by the number of persons in the working population l_x^w the answer is the "average expectation of working life" for persons of that age.

13. The cumulative total number of man-years in the working population from any age-interval onwards is designated by the symbol T_x^w, and the figures on this basis for each year of age are given in Column 9 of Table 1. The "average expectation of working life" is designated by the symbol $\mathring{e}_x^w$ and the figures are given in Column 10.

III. Losses from the Working Population

14. The figures of working life given in the table are of value not only for the purpose of estimating the expectation of working life but also for the reason that they enable analyses to be made of the numbers leaving the working population at different ages. In the ordinary life table there is only one way in which the population can be reduced, viz., by death. In the working-life table the working population is reduced by (1) death and (2) persons leaving the working population by retirement for whatever reason such as illness, injury, retirement with pension, etc. The difference between two successive figures in the l_x^w column can be defined as the "net" number leaving the working population between exact ages x and $x + 1$. It is net in that it is the difference between the number of entrants into employment during that age-interval and the number leaving employment.

15. For men, it is probable that the number of entrants into employment at all ages other than the ages at which they come from schools and colleges is relatively very small and the differences between successive l_x^w figures can therefore be taken to represent "losses" from the working population. These differences, represented by the symbol "s_x^w", are given in Column 11 of the table. They represent total losses from the working population resulting from deaths on the one hand and losses from all other causes ("retirements") on the other. On the assumption that the death rate for men in the working population is the same as the death rate for all men of the same age, it is possible to divide the total losses given in Column 11 into these two components. There is obviously some risk of error in making this assumption but it is probably not very great. Persons in the working population are no doubt healthier, on the average, than those not in the working population, but on the other hand they are subject to certain additional risks (e.g. from industrial accidents and above-average mortality rates associated with certain occupations).

16. It is shown in the Technical Appendix (para. 13) that the number of deaths, between two exact years of age, of persons in the working population can be closely estimated by multiplying the average number in the working population between those ages (i.e. L_x^w) by the "central death rate" for all persons of the same age. The central death rate is obtained by taking the difference between the population at two consecutive exact years of age and dividing it by the average number in the population between the two age-points. The central death rate is conventionally denoted by m_x, and in terms of the symbols in Table 1 the formula for its computation is:

$$m_x = \frac{l_x - l_{x+1}}{L_x}$$

The number of deaths from the working population at each exact year of age (excluding deaths after retirement) can therefore be computed by multiplying L_x^w for that age by the corresponding m_x. The results of this computation are shown in Column 13 in Table 1 under the symbol d_x^w.

17. As stated above, the losses from the working population from *all* causes are shown in Column 11 of Table 1 under the symbol (s_x^w). These total losses, of course, include the numbers of persons who die while in the working population (d_x^w) and the differences between the two figures therefore represent the number of losses from the working population through causes other than deaths. These differences are shown in Column 15 of the table under the symbol r_x^w.

18. The final step is to express these numbers of losses as rates per thousand. In considering the various possible bases for such rates attention was given to the practical uses which might be made of them. One of their most obvious uses, and probably one of the most important, is to estimate the probable annual losses from the actual working population as established from Census or other sources. For this purpose it is essential that the loss rates in the working-life table should be based on the figures in the table which are most closely analogous in form to an age-distribution obtained from a Census. The figures which meet this requirement are those given in Column 8 of Table 1 under the symbol L_x^w, and the three figures of losses from the working population (all losses (s_x^w), losses through death (d_x^w) and losses through other causes (r_x^w)) have accordingly been expressed as rates per thousand of the figures in that column. The rates thus obtained are shown in Columns 12, 14 and 16 of the table under the symbols m_x^s, m_x^d and m_x^r respectively. They can be described as central rates of losses from the working population. The death rate obtained in this way (m_x^d) is equal to the corresponding central death rate for the total population (m_x) that has already been referred to.

IV. Length of Working Life of Males in Great Britain(3)

19. Table 1 shows that on the basis of the 1952–54 mortality rates for males, 9,597 out of the initial group of 10,000 males born alive can be expected to reach their fifteenth birthday. Of these, 9,568 or 99·7 per cent. can be expected to join the working population at some time subsequent to their fifteenth birthday. The 9,597 boys surviving at age 15 may expect to have a total of 526,929 man-years of life remaining—an average of 54·9 years per boy. Some boys aged 15 will of course die before they reach 70 years of age and some will live longer. The "expectation" is only an average for a large group. This expectation declines steadily as age increases so that, for example, those men who have survived to age 65 have an expectation of a further 11·9 years of life on the average. Since there are two sources of depletion of the numbers in the working population, viz., deaths and retirements, the expectation of remaining in the working population is lower than the expectation of life at each year of age. Thus while a boy of 15 has an expectation of life of 54·9 years, a boy of 15 who has just joined the working population has an expectation of 48·4 years in the working population. Similarly, at age 65 a man has an expectation of 11·9 years of life remaining, but for those still in the working population an expectation of only 4·3 years in the working population.

20. It is important not to misunderstand the meaning of the difference at any age between the expectation of life and the expectation of working life ($\mathring{e}_x - \mathring{e}^w_x$). For boys aged 15 entering the working population there is an expectation on the average of 48·4 years in the working population and 6·5 years (54·9 *minus* 48·4) outside the working population. Furthermore, as stated above, those who reach their 65th birthday while still in the working population have an expectation of life of 11·9 years and of 4·3 years remaining in the working population. But this does not mean that a man *retiring at 65* may expect only 6·5 or 7·6 (i.e. 11·9 — 4·3) years in retirement. In compiling the working-life table the assumption has been made that the expectation of life is the same for those in the working population as for those not in the working population. This assumption is reasonable for most of the years of age up to about 65 but may be less so for ages over 65. On the other hand the figures of expectation of life at ages over 65 relate to men most of whom have retired. It follows therefore that even if the real expectation of life of those in retirement is less than the expectation of life of those who remain in the working population that expectation must be very close to the figures shown in Column 6. We can therefore say that those who retire at, say, age 65 have an expectation of life in retirement of something like 11·9 years. This can be seen more clearly by considering not the *average* expectation but the *aggregate* man-years remaining at age 15 for those in the working population. Column 9 of Table 1 shows that the 9,568 boys at exact age 15 in the working population may expect to live 463,351 man-years in the working population. Assuming that mortality rates are the same for those in the working population as for those not in the working population these 9,568 boys may expect an aggregate of 9,568 × 54·9 = 525,283 man-years remaining. The difference between these two figures viz. 61,932, represents the number of man-years that the 9,568 boys aged 15 may expect to spend outside the working population, i.e., an average of 6·5 years. It will be seen that this average of 6·5 years is the result of dividing the total number of man-years spent outside the working population by a total of men which includes not only those who do achieve retirement but also those who die while still in the working population.

21. Since most of the losses from the working population up to age 65 are those from death rather than from retirement, these losses affect both the expectation of life and the expectation of working life to the same degree. The result is that the difference between the expectation of life and the expectation of working life varies little at ages between 15 and 65.

22. It will be seen that while the expectation of remaining in the working population generally decreases with advancing age there are a few exceptions. For example the expectation of working life at 66 is 5·5 years compared with 4·3 years at 65. Retirement, although associated strongly with age, is to an increasing extent determined by social and other factors. Thus, as a result of the national insurance scheme, large numbers of persons retire from the working population in their 65th year. It follows that men in the working population at age 65 include an abnormally large number whose expectation of remaining in the working population is less than one year and as a consequence the average expectation is reduced. Those who remain in the working population at 66 will therefore include a larger proportion whose expectation of remaining in the working population is greater than one year and the average expectation for that age is correspondingly increased. Estimates of the numbers remaining in the working population at higher ages are subject to increasing margins of error and figures for individual years of age

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(3) It cannot be too strongly emphasized that the figures of expectation of working life and the figures of loss rates for specific ages are averages for the whole male working population of Great Britain. The figures for any particular occupational or other group will differ from the national averages owing to differences in age-specific retirement and mortality rates.

above 76 have therefore been omitted from the tables. Those figures have, however, been used in computing the expectation of working life.

23. In compiling these tables of working life the expectation of working life has been defined as the expectation at each age for those *in the working population* at that age. For some purposes however, it is desirable to consider the expectation of working life of the *total number alive*. In particular, it is useful to consider the expectation of working life at birth. It will be seen that on the basis of the 1955 table the survivors of 10,000 males born alive can expect to spend 463,351 man-years in the working population—an expectation at birth of 46·3 years.

24. The figure of 463,351 man-years has been calculated on the assumption that all those who at some time after the age of 15 join the working population are regarded as being in the working population from age 15. For some purposes it is desirable to have an estimate of the total number of man-years that will be spent in the working population, excluding time spent in full-time education, after 15, by the 10,000 born alive. If a deduction is made for those man-years in full-time education after 15 the total number of man-years of working life remaining at exact age 15 is reduced from 463,351 to 455,508 and the expectation of working life at birth is 45·6 years instead of 46·3 years. Figures on this alternative basis are given in the second footnote to Tables 1 and 2.

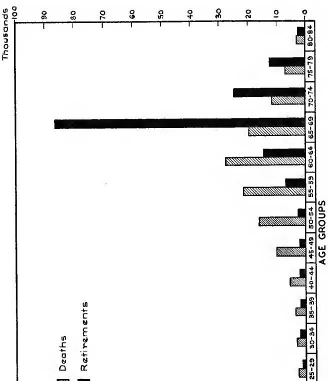
V. Probabilities of Remaining in or Leaving the Working Population

25. In addition to the figures of working life expectancy and the central loss rates, the table of working life contains information which enables answers to be given to questions about the probability or chance of remaining in the working population or of leaving it owing to death or retirement. It is usual to express a probability by a decimal fraction varying between 0 and 1—certainty being represented by 1. If there is one chance in four that a particular event will occur its probability would be expressed as 0·25. Thus the probability that a man of exact age 40 in the working population will still be in the working population at exact age 50 can be found from Column 7 of Table 1. The number in the working population at age 40 is 9,125 and of these the number still in the working population at age 50 is 8,635, The probability is therefore equal to $\frac{8,635}{9,125} = 0\cdot 946$. These probabilities may perhaps be more readily understood if they are multiplied by 100 and expressed in percentage form. Thus in the example just given we could say that 94·6 per cent. of the men of exact age 40 in the working population can expect to remain in the working population to age 50.

26. From Column 3 of Table 1 it will be seen that out of 10,000 boys born alive, 9,597 (or 96·0 per cent.) can be expected to survive to the school-leaving age of 15. Column 7 shows that 7,250 (or 72·5 per cent.) of the 10,000 boys can be expected to be in the working population at age 60; 5,849 (or 58·5 per cent.) to be still in the working population at age 65, and 2,146 (or 21·5 per cent.) at age 70.

27. Of these 10,000 boys born alive, 4,882 (or 48·8 per cent.) can be expected to "retire" from the working population after reaching their 60th birthday and 1,831 (or 18·3 per cent.) to retire between their 65th and 66th birthdays.

28. Of the 9,568 boys at age 15 in the working population or in full-time education, 4,214 (or 44 per cent.) can be expected to leave the working population by death and 5,354 (or 56 per cent.) to leave for a cause other than death. As many as 4,407 (or 46 per cent.) will "retire" after reaching their 65th birthday.



Estimated age distribution of losses from the male working population of Great Britain in 1955

VI. Changes between 1931 and 1955

29. In order to show what changes had taken place since before the war a table similar to the 1955 table has been prepared for 1931 (Table 2). This was based on the Census of Population figures for that year and the mortality experience of the years 1930–32.

30. In comparing 1955 with 1931 it is necessary to keep in mind two important changes resulting from legislation. The school leaving age was raised from 14 to 15 in 1947 and the retirement pensions scheme under the National Insurance Act of 1948 differed from the pre-war pensions scheme in that "retirement" was made a condition for the receipt of pensions under the scheme. It is probable that this "retirement" condition, coupled with the great extension of private pension schemes, accounted to some extent for the much larger number of retirements in 1955 immediately on reaching the minimum pension age of 65. There were, of course, other important changes, especially in mortality. Thus Table 1 shows that, in 1955, out of 10,000 males born alive, 9,597 can be expected to reach their fifteenth birthday, while Table 2 shows that in 1931 only 8,795 could be expected to survive until 15. At age 15 the expectation of life was 54·9 years in 1955 compared with 51·1 years in 1931; in fact the expectation of life was greater at all ages in 1955 than in 1931. This increased expectation of life (or reduction in the rate of mortality) coupled with some reduction in the losses from the working population through causes other than death resulted in an increase in the expectation of working life, which was 48·4 years for those aged 15 in 1955 compared with 46·6 years in 1931. This occurred in spite of the fact that there was a much greater peak of retirements at age 65 in 1955 than in 1931 and that the expectation of working life was in fact *lower* in 1955 than in 1931 for ages above 45. The number of man-years in the working population for age 65 and upwards is lower in the 1955 Table than in the 1931 Table (25,336 compared with 28,253), but at all ages up to 65 the number of man-years (i.e. L_x^w) is considerably higher in the 1955 Table than in 1931.

31. Reference was made in para. 30 to the fact that owing to the reduction in the rate of mortality in the early years of life the number surviving at age 15, out of 10,000 born alive, was much greater in 1955 than in 1931. In other words a much larger number in 1955 survived to the age when they could enter the working population. It is useful in this connection to compare the aggregate number of man-years spent in the working population (excluding years spent in full-time education) by the two groups. The 10,000 boys born alive in 1931 could expect to spend 406,018 man-years at work after reaching the school-leaving age of 14, an average of 40·6 years. The 10,000 born alive in 1955, on the other hand, could expect to spend 455,508 man-years at work after reaching the school leaving age of 15, an average of 45·6 years. Thus the expectation of working life at birth rose from 40·6 years to 45·6 years, an increase of 12½ per cent. The increase due to the reduction in the mortality rate, both below and above 15 years of age, greatly outweighed the effect of the raising of the school-leaving age and of the movement to earlier retirement.

32. Reference was also made in para. 30 to the fact that the number of man-years in the working population for age 65 and upwards was lower for the 1955 group than for the 1931 group, although the number in the working population at exact age 65 in 1955 was higher than in 1931. This was due to the fact that a much larger proportion of the working population aged 65 in the 1955 table could expect to spend some time in retirement than was the case in 1931 (75 per cent. compared with 58 per cent.) coupled with the fact that the proportion retiring very soon after reaching 65 years of age was very much higher in 1955. Thus, of the working population of 4,412 at exact age 65 in the 1931 table, 432, or 10 per cent., retired before reaching their 66th birthday. In the 1955 table, on the other hand, the working population at exact age 65 was 5,849, of whom 1,831, or 31 per cent., retired before reaching their 66th birthday. Another feature of the difference between the two years was the smaller number in 1955 who could expect to delay their retirement till the age of 75 or later, the number being 499, or 8½ per cent. of the number working at age 65, compared with 574 (13 per cent.) in 1931.

VII. Estimated Losses from the Working Population in 1955

33. The central loss rates given in Columns 14 and 16 of the tables show for each year of age the rates at which the working population is depleted owing to death on the one hand and to losses from causes other than death on the other hand. The numerator in this rate—i.e., d_x^w or r_x^w—represents the number of men who can be expected to die or to retire between exact ages x and $x + 1$. The denominator L_x^w represents the number of men in the working population between those ages at a given point of time. It follows therefore that if we have a table giving for individual years of age the actual number of men in the working population from age 15 we can estimate the expected annual losses from that working population through death or other causes by multiplying the numbers in each year of age by the corresponding rates shown in Columns 14 and 16. The resulting figures would represent the expected losses from the actual working population on the assumption that this population was subject to the specific age mortality and retirement rates used in constructing the working-life table. These calculations have been carried out on the figures of the actual working population as at the middle of 1955 used in constructing the working-life table. The multiplications were made for each year of age and the results are shown in the table above for quinquennial age groups.

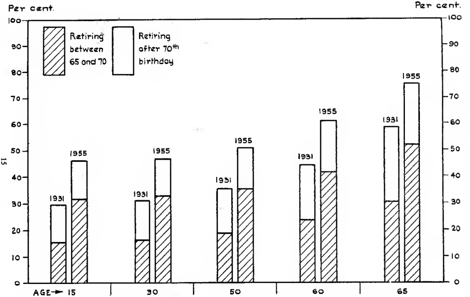
ESTIMATED AGE DISTRIBUTION OF LOSSES FROM THE MALE WORKING POPULATION OF GREAT BRITAIN IN 1955(a)

Age at death or retirement	Estimated losses in 1955 from the working population		
	Total losses	Due to death	Due to causes other than death
15–19 . . .	1,150	1,150	—
20–24 . . .	1,940	1,940	—
25–29 . . .	2,830	2,180	650
30–34 . . .	4,710	2,840	1,870
35–39 . . .	5,050	3,430	1,620
40–44 . . .	7,630	5,840	1,790
45–49 . . .	11,860	10,100	1,760
50–54 . . .	18,840	16,520	2,320
55–59 . . .	28,040	21,490	6,550
60–64 . . .	41,350	27,360	13,990
65–69 . . .	105,440	19,190	86,250
70–74 . . .	37,280	12,340	24,940
75–79 . . .	19,430	6,760	12,670
80–84 . . .	5,030	2,670	2,360
85–89 . . .	1,200	580	620
TOTAL . .	291,780	134,390	157,390

(a) Excluding losses from emigration.

34. The total number of men in the working population at end May 1955 was 16,084,000. The total loss rate per annum was therefore 18·1 per thousand. The loss rate from death was 8·4 per thousand and the loss rate from retirement 9·7 per thousand.

35. Similar total rates may be computed from the working-life table. The numbers of men in the working population in each year of age (Column 8) represent also the numbers in each of those ages that would be found in a "stationary" population in which the constant number (10,000) of births each year equalled the constant number (10,000) of deaths. The total of the numbers in Column 8 (including those aged 77 and over) is 463,351. The total losses in a year from this population are 9,568, 4,214 being due to death and 5,354 due to causes other than death. The total loss rate in the stationary population is therefore 20·6 per thousand. The loss rate from death is 9·1 per thousand and the loss rate from causes other than death is 11·5 per thousand. The differences between these rates and those computed above for the actual working population in 1955 reflect the differences in the age distribution of the actual working population in 1955 and the stationary working population. The stationary population of the life table contains relatively more men in the higher age groups for which the loss rates are above average. Similarly since for these higher age groups the retirement rate is greater than the death rate the ratio of the total retirement rate to the total death rate is greater for the stationary population than it is for the actual population of 1955.



Percentage of men at certain ages in the working population who can expect to remain in the working population until age 65 and to retire at some time thereafter

TABLE 1. TABLE OF WORKING LIFE OF MALES IN GREAT BRITAIN, 1955

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		NUMBER LIVING OF 10,000 BORN ALIVE				NUMBER IN WORKING POPULATION OF 10,000 BORN ALIVE				LOSSES FROM THE WORKING POPULATION(1)					
										TOTAL		DUE TO DEATH		DUE TO CAUSES OTHER THAN DEATH	
AGE	PERCENTAGE OCCUPIED AT EXACT AGE x	At exact age x	In year of age x	In year of age x and all later years	EXPECTATION OF LIFE AT EXACT AGE x	At exact age x	In year of age x	In year of age x and all later years	EXPECTATION OF WORKING LIFE AT EXACT AGE x	Number	Per 1,000 in working population	Number	Per 1,000 in working population	Number	Per 1,000 in working population
x	w_x	l_x	L_x	T_x	$\mathring{e}_x$	l_x^w	L_x^w	T_x^w	$\mathring{e}_x^w$	s_x^w	$1,000m_x^s$	d_x^w	$1,000m_x^d$	r_x^w	$1,000m_x^r$
15	99·7	9,597	9,594	526,929	54·9	9,568	9,565	463,351(2)	48·4	7	0·7	7	0·7	—	—
16	99·7	9,590	9,586	517,335	53·9	9,561	9,557	453,786	47·5	8	0·8	8	0·8	—	—
17	99·7	9,582	9,578	507,749	53·0	9,553	9,549	444,229	46·5	8	0·8	8	0·8	—	—
18	99·7	9,574	9,570	498,171	52·0	9,545	9,541	434,680	45·5	9	0·9	9	0·9	—	—
19	99·7	9,565	9,560	488,601	51·1	9,536	9,531	425,139	44·6	10	1·0	10	1·0	—	—
20	99·7	9,555	9,550	479,041	50·1	9,526	9,521	415,608	43·6	11	1·2	11	1·2	—	—
21	99·7	9,544	9,538	469,491	49·2	9,515	9,509	406,087	42·7	11	1·2	11	1·2	—	—
22	99·7	9,533	9,527	459,953	48·2	9,504	9,498	396,578	41·7	11	1·2	11	1·2	—	—
23	99·7	9,521	9,515	450,426	47·3	9,493	9,487	387,080	40·8	12	1·3	12	1·3	—	—
24	99·7	9,509	9,503	440,911	46·4	9,481	9,475	377,593	39·8	12	1·3	12	1·3	—	—
25	99·7	9,497	9,491	431,408	45·4	9,469	9,463	368,118	38·9	12	1·3	12	1·3	—	—
26	99·7	9,485	9,479	421,917	44·5	9,457	9,451	358,655	37·9	12	1·3	12	1·3	—	—
27	99·7	9,473	9,467	412,438	43·5	9,445	9,439	349,204	37·0	12	1·3	12	1·3	—	—
28	99·7	9,461	9,455	402,971	42·6	9,433	9,422	339,765	36·0	22	2·3	12	1·3	10	1·0
29	99·6	9,449	9,443	393,516	41·6	9,411	9,401	330,343	35·1	21	2·2	12	1·3	9	0·9
30	99·5	9,437	9,431	384,073	40·7	9,390	9,379	320,942	34·2	22	2·3	12	1·3	10	1·0
31	99·4	9,425	9,419	374,642	39·7	9,368	9,357	311,563	33·3	22	2·4	13	1·4	9	1·0
32	99·3	9,412	9,405	365,223	38·8	9,346	9,335	302,206	32·3	23	2·5	14	1·5	9	1·0
33	99·2	9,398	9,390	355,818	37·9	9,323	9,311	292,871	31·4	25	2·7	16	1·7	9	1·0
34	99·1	9,382	9,374	346,428	36·9	9,298	9,285	283,560	30·5	27	2·9	17	1·8	10	1·1
35	99·0	9,365	9,356	337,054	36·0	9,271	9,258	274,275	29·6	27	2·9	18	1·9	9	1·0
36	98·9	9,347	9,338	327,698	35·1	9,244	9,230	265,017	28·7	28	3·0	18	2·0	10	1·0
37	98·8	9,328	9,318	318,360	34·1	9,216	9,202	255,787	27·8	29	3·2	19	2·1	10	1·1
38	98·7	9,308	9,298	309,042	33·2	9,187	9,172	246,585	26·8	30	3·3	21	2·3	9	1·0
39	98·6	9,287	9,276	299,744	32·3	9,157	9,141	237,413	25·9	32	3·5	23	2·5	9	1·0
40	98·5	9,264	9,252	290,468	31·4	9,125	9,109	228,272	25·0	33	3·6	24	2·6	9	1·0
41	98·4	9,240	9,227	281,216	30·4	9,092	9,075	219,163	24·1	35	3·9	25	2·8	10	1·1
42	98·3	9,214	9,200	271,989	29·5	9,057	9,039	210,088	23·2	37	4·1	29	3·2	8	0·9
43	98·2	9,185	9,169	262,789	28·6	9,020	8,999	201,049	22·3	42	4·7	32	3·6	10	1·1
44	98·1	9,152	9,133	253,620	27·7	8,978	8,955	192,050	21·4	46	5·1	38	4·2	8	0·9
45	98·0	9,114	9,093	244,487	26·8	8,932	8,907	183,095	20·5	51	5·7	41	4·6	10	1·1
46	97·9	9,072	9,049	235,394	25·9	8,881	8,854	174,188	19·6	55	6·2	46	5·2	9	1·0
47	97·8	9,025	9,000	226,345	25·1	8,826	8,797	165,334	18·7	58	6·6	50	5·7	8	0·9
48	97·7	8,974	8,946	217,345	24·2	8,768	8,736	156,537	17·9	64	7·3	55	6·3	9	1·0
49	97·6	8,918	8,887	208,399	23·4	8,704	8,670	147,801	17·0	69	8·0	61	7·0	8	1·0

50	97·5	8,856	8,821	199,512	22·5	8,635	8,597	139,131	16·1	77	9·0	68	7·9	9	1·1
51	97·4	8,786	8,746	190,691	21·7	8,558	8,515	130,534	15·3	87	10·2	77	9·0	10	1·2
52	97·3	8,706	8,661	181,945	20·9	8,471	8,423	122,019	14·4	96	11·4	88	10·4	8	1·0
53	97·2	8,616	8,566	173,284	20·1	8,375	8,318	113,596	13·6	115	13·8	98	11·8	17	2·0
54	97·0	8,515	8,460	164,718	19·3	8,260	8,198	105,278	12·7	125	15·2	107	13·1	18	2·1
55	96·8	8,404	8,344	156,258	18·6	8,135	8,064	97,080	11·9	142	17·6	117	14·5	25	3·1
56	96·5	8,283	8,218	147,914	17·9	7,993	7,914	89,016	11·1	159	20·1	126	15·9	33	4·2
57	96·1	8,152	8,082	139,696	17·1	7,834	7,747	81,102	10·4	175	22·6	135	17·4	40	5·2
58	95·6	8,011	7,935	131,614	16·4	7,659	7,559	73,355	9·6	201	26·6	145	19·2	56	7·4
59	94·9	7,859	7,778	123,679	15·7	7,458	7,354	65,796	8·8	208	28·3	154	21·0	54	7·3
60	94·2	7,696	7,609	115,901	15·1	7,250	7,138	58,442	8·1	225	31·5	164	23·0	61	8·5
61	93·4	7,521	7,427	108,292	14·4	7,025	6,904	51,304	7·3	242	35·1	175	25·4	67	9·7
62	92·5	7,333	7,232	100,865	13·8	6,783	6,654	44,400	6·5	258	38·8	186	28·0	72	10·8
63	91·5	7,131	7,023	93,633	13·1	6,525	6,374	37,746	5·8	302	47·4	197	30·9	105	16·5
64	90·0	6,914	6,799	86,610	12·5	6,223	6,036	31,372	5·0	374	62·0	204	33·8	170	28·2
65	87·5	6,684	6,563	79,811	11·9	5,849	4,150	25,336	4·3	1,984	478·1	153	36·9	1,831	441·2
66	60·0	6,442	6,315	73,248	11·4	3,865	3,604	21,186	5·5	523	145·1	145	40·2	378	104·9
67	54·0	6,188	6,056	66,933	10·8	3,342	3,116	17,582	5·3	452	145·1	136	43·7	316	101·4
68	48·8	5,923	5,786	60,877	10·3	2,890	2,688	14,466	5·0	405	150·7	128	47·6	277	103·1
69	44·0	5,648	5,506	55,091	9·8	2,485	2,316	11,778	4·7	339	146·4	120	51·8	219	94·6
70	40·0	5,364	5,218	49,585	9·2	2,146	1,910	9,462	4·4	472	247·1	107	56·0	365	191·1
71	33·0	5,072	4,922	44,367	8·7	1,674	1,529	7,552	4·5	290	189·7	93	60·8	197	128·9
72	29·0	4,772	4,619	39,445	8·3	1,384	1,273	6,023	4·4	223	175·2	85	66·8	138	108·4
73	26·0	4,465	4,309	34,826	7·8	1,161	1,069	4,750	4·1	185	173·1	78	73·0	107	100·1
74	23·5	4,152	3,993	30,517	7·3	976	900	3,681	3·8	152	168·9	72	80·0	80	88·9
75	21·5	3,834	3,674	26,524	6·9	824	711	2,781	3·4	227	319·3	62	87·2	165	232·1
76[1]	17·0	3,513	3,352	22,850	6·5	597	530	2,070	3·5	134	252·8	51	96·2	83	156·6

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[1] For various reasons the figures for individual years of age after age 76 are of doubtful value and they have therefore been omitted from the table. They are, however, included in the cumulative totals in Columns 5 and 9 and are accordingly taken into account in the computation of Columns 6 and 10. The total number lost from the working population (Column 11) at age 77 and higher ages was 463, the number due to death (Column 13) being 212 and the number due to retirement (Column 15) 251.

For the three quinquennial groups 75–79, 80–84 and 85–89 columns 4, 8, 11, 13 and 15 read as follows:

x	L_x	L_x^w	s_x^w	d_x^w	r_x^w
75–79	15,164	2,184	629	222	407
80–84	7,729	507	155	82	73
85–89	2,861	88	38	20	18

[2] For each year of age from 15 to 27 the figures in Columns 7, 8 and 9 include persons in training for employment (i.e. continuing full-time education) as well as those in employment (*see* para. 7 of Technical Appendix). If the former category were excluded the figures would be as follows :—

Age	l_x^w	L_x^w	T_x^w
15	—	6,293	455,508
16	7,250	7,808	449,215
17	8,365	8,735	441,407
18	9,105	9,283	432,672
19	9,460	9,436	423,389
20	9,412	9,302	413,953
21	9,191	9,186	404,651
22	9,180	9,060	395,465
23	8,940	8,997	386,405
24	9,053	9,266	377,408
25	9,478	9,468	368,142
26	9,457	9,465	358,674
27	9,473	9,444	349,209

TABLE 2. TABLE OF WORKING LIFE OF MALES IN GREAT BRITAIN, 1931

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
AGE	PERCENTAGE OCCUPIED AT EXACT AGE x	NUMBER LIVING OF 10,000 BORN ALIVE			EXPECTATION OF LIFE AT EXACT AGE x	NUMBER IN WORKING POPULATION OF 10,000 BORN ALIVE			EXPECTATION OF WORKING LIFE AT EXACT AGE x	LOSSES FROM THE WORKING POPULATION(3)					
										TOTAL		DUE TO DEATH		DUE TO CAUSES OTHER THAN DEATH	
		At exact age x	In year of age x	In year of age x and all later years		At exact age x	In year of age x	In year of age x and all later years		Number	Per 1,000 in working population	Number	Per 1,000 in working population	Number	Per 1,000 in working population
x	w_x	l_x	L_x	T_x	$\mathring{e}_x$	l_x^w	L_x^w	T_x^w	$\mathring{e}_x^w$	s_x^w	$1{,}000m_x^s$	d_x^w	$1{,}000m_x^d$	r_x^w	$1{,}000m_x^r$
14	98·7	8,810	8,803	458,261	52·0	8,695	8,688	413,038(5)	47·5	14	1·6	14	1·6	—	—
15	98·7	8,795	8,787	449,458	51·1	8,681	8,673	404,350	46·6	17	2·0	17	2·0	—	—
16	98·7	8,778	8,768	440,672	50·2	8,664	8,654	395,677	45·7	20	2·3	20	2·3	—	—
17	98·7	8,758	8,747	431,904	49·3	8,644	8,633	387,023	44·8	23	2·6	23	2·6	—	—
18	98·7	8,735	8,723	423,157	48·4	8,621	8,609	378,390	43·9	24	2·8	24	2·8	—	—
19	98·7	8,710	8,697	414,434	47·6	8,597	8,584	369,781	43·0	26	3·0	26	3·0	—	—
20	98·7	8,684	8,670	405,737	46·7	8,571	8,558	361,197	42·1	27	3·1	27	3·1	—	—
21	98·7	8,657	8,642	397,067	45·9	8,544	8,530	352,639	41·3	28	3·3	28	3·3	—	—
22	98·7	8,628	8,614	388,424	45·0	8,516	8,502	344,109	40·4	28	3·3	28	3·3	—	—
23	98·7	8,600	8,585	379,810	44·2	8,488	8,474	335,607	39·5	28	3·4	28	3·4	—	—
24	98·7	8,571	8,557	371,225	43·3	8,460	8,446	327,133	38·7	29	3·4	29	3·4	—	—
25	98·7	8,542	8,528	362,668	42·5	8,431	8,417	318,687	37·8	28	3·3	28	3·3	—	—
26	98·7	8,514	8,500	351,141	41·6	8,403	8,390	310,270	36·9	27	3·3	27	3·3	—	—
27	98·7	8,486	8,472	345,641	40·7	8,376	8,362	301,880	36·0	28	3·3	28	3·3	—	—
28	98·7	8,458	8,443	337,169	39·9	8,348	8,334	293,518	35·2	29	3·5	28	3·4	1	0·1
29	98·7	8,429	8,415	328,726	39·0	8,319	8,304	285,184	34·3	31	3·7	27	3·3	4	0·4
30	98 65	8,401	8,386	320,311	38·1	8,288	8,272	276,880	33·4	33	4·0	29	3·5	4	0·5
31	98 6	8,372	8,357	311,925	37·3	8,255	8,238	268,608	32·6	34	4·1	30	3·6	4	0·5
32	98·55	8,342	8,327	303,568	36·4	8,221	8,204	260,370	31·7	35	4·3	30	3·7	5	0·6
33	98·5	8,311	8,296	295,241	35·5	8,186	8,167	252,166	30·8	38	4·7	30	3·7	8	1·0
34	98·4	8,280	8,263	286,946	34·7	8,148	8,129	243,999	30·0	38	4·7	33	4·1	5	0·6
35	98·35	8,246	8,228	278,683	33·8	8,110	8,090	235,870	29·1	40	4·9	36	4·4	4	0·5
36	98·3	8,210	8,192	270,455	32·9	8,070	8,050	227,780	28·2	40	5·0	36	4·5	4	0·5
37	98·25	8,173	8,153	262,263	32·1	8,030	8,009	219,730	27·4	43	5·4	39	4·9	4	0·5
38	98·2	8,133	8,113	254,110	31·2	7,987	7,965	211,721	26·5	45	5·7	41	5·1	4	0·6
39	98·15	8,092	8,070	245,997	30·4	7,942	7,919	203,756	25·7	47	5·9	44	5·5	3	0·4
40	98·1	8,048	8,025	237,928	29·6	7,895	7,871	195,837	24·8	49	6·2	45	5·7	4	0·5
41	98·05	8,002	7,978	229,903	28·7	7,846	7,820	187,966	24·0	52	6·7	48	6·1	4	0·6
42	98·0	7,953	7,927	221,925	27·9	7,794	7,767	180,146	23·1	54	7·0	50	6·4	4	0·6
43	97·95	7,902	7,874	213,998	27·1	7,740	7,711	172,379	22·3	59	7·7	55	7·1	4	0·6
44	97·9	7,846	7,817	206,124	26·3	7,681	7,649	164,668	21·4	65	8·5	57	7 5	8	1·0
45	97·8	7,787	7,756	198,307	25·5	7,616	7,578	157,019	20·6	77	10·2	61	8·1	16	2·1
46	97·6	7,724	7,691	190,551	24·7	7,539	7,499	149,441	19·8	81	10·8	65	8·7	16	2·1
47	97·4	7,657	7,622	182,860	23·9	7,458	7,416	141,942	19·0	84	11·3	69	9·3	15	2·0
48	97·2	7,586	7,548	175,239	23·1	7,374	7,330	134,526	18·2	89	12·1	74	10·1	15	2·0
49	97·0	7,510	7,470	167,691	22·3	7,285	7,239	127,196	17·5	92	12·7	77	10·6	15	2·1

50	96·8	7,431	7,389	160,220	21·6	7,193	7,145	119,957	16·7	96	13·4	81	11·3	15	2·1
51	96·6	7,347	7,302	152,832	20·8	7,097	7,047	112,812	15·9	100	14·2	86	12·2	14	2·0
52	96·4	7,258	7,211	145,529	20·1	6,997	6,945	105,765	15·1	105	15·1	90	13·0	15	2·1
53	96·2	7,164	7,114	138,319	19·3	6,892	6,837	98,820	14·3	111	16·2	96	14·0	15	2·2
54	96·0	7,064	7,011	131,205	18·6	6,781	6,720	91,983	13·6	122	18·2	101	15·1	21	3·1
55	95·7	6,958	6,902	124,194	17·8	6,659	6,588	85,263	12·8	143	21·7	108	16·4	35	5·3
56	95·2	6,845	6,785	117,292	17·1	6,516	6,440	78,675	12·1	153	23·8	113	17·6	40	6·2
57	94·6	6,726	6,662	110,507	16·4	6,363	6,280	72,235	11·4	167	26·6	121	19·3	46	7·3
58	93·9	6,598	6,530	103,845	15·7	6,196	6,106	65,955	10·6	180	29·5	127	20·8	53	8·7
59	93·1	6,462	6,390	97,315	15·1	6,016	5,908	59,849	9·9	216	36·6	133	22·5	83	14·1
60	91·8	6,318	6,241	90,925	14·4	5,800	5,674	53,941	9·3	252	44·4	140	24·7	112	19·7
61	90·0	6,164	6,082	84,684	13·7	5,548	5,414	48,267	8·7	268	49·5	146	27·0	122	22·5
62	88·0	6,000	5,914	78,602	13·1	5,280	5,146	42,853	8·1	268	52·1	150	29·2	118	22·9
63	86·0	5,828	5,736	72,688	12·5	5,012	4,877	37,707	7·5	271	55·6	157	32·2	114	23·4
64	84·0	5,644	5,546	66,952	11·9	4,741	4,577	32,830	6·9	329	71·9	162	35·4	167	36·5
65	81·0	5,447	5,344	61,407	11·3	4,412	4,009	28,253	6·4	587	146·4	155	38·7	432	107·7
66	73·0	5,240	5,130	56,063	10·7	3,825	3,620	24,244	6·3	411	113·5	155	42·8	256	70·7
67	68·0	5,020	4,905	50,933	10·1	3,414	3,216	20,624	6·0	396	123·1	151	46·9	245	76·2
68	63·0	4,790	4,670	46,028	9·6	3,018	2,828	17,408	5·8	380	134·4	146	51·6	234	82·8
69	58·0	4,548	4,423	41,359	9·1	2,638	2,479	14,580	5·5	318	128·3	141	56·9	177	71·4
70	54·0	4,297	4,167	36,936	8·6	2,320	2,189	12,101	5·2	262	119·7	137	62·6	125	57·1
71	51·0	4,036	3,902	32,769	8·1	2,058	1,934	9,912	4·8	249	128·8	133	68·8	116	60·0
72	48·0	3,768	3,631	28,867	7·7	1,809	1,673	7,978	4·4	272	162·6	126	75·3	146	87·3
73	44·0	3,494	3,355	25,236	7·2	1,537	1,412	6,305	4·1	251	177·8	117	82·9	134	94·9
74	40·0	3,215	3,075	21,882	6·8	1,286	1,172	4,893	3·8	229	195·4	107	91·3	122	104·1
75	36·0	2,935	2,794	18,807	6·4	1,057	953	3,721	3·5	208	218·2	96	100·7	112	117·5
76(1)	32·0	2,654	2,516	16,012	6·0	849	758	2,768	3·3	183	241·4	83	109·5	100	131·9

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(1) For various reasons the figures for individual years of age after age 76 are of doubtful value and they have therefore been omitted from the table. They are, however, included in the cumulative totals in Columns 5 and 9 and are accordingly taken into account in the computation of Columns 6 and 10. The total number lost from the working population (Column 11) at age 77 and higher ages was 666, the number due to death (Column 13) being 304 and the number due to retirement (Column 15) 362.

For the three quinquennial groups 75–79, 80–84 and 85–89, Columns 4, 8, 11, 13 and 15 read as follows:

x	L_x	L_x^w	s_x^w	d_x^w	r_x^w
75–79	11,190	3,048	801	353	448
80–84	5,365	578	212	103	109
85–89	1,778	94	40	24	16

(2) For each year of age from 14 to 27 the figures in Columns 7, 8 and 9 include persons in training for employment (i.e. continuing full-time education) as well as those in employment (*see* para. 7 of Technical Appendix). If the former category were excluded the figures would be as follows:

Age	l_x^w	L_x^w	T_x^w
14	—	6,162	406,018
15	6,157	6,809	399,856
16	7,461	7,759	393,047
17	8,057	8,156	385,288
18	8,255	8,287	377,132
19	8,318	8,336	368,845
20	8,354	8,354	360,509
21	8,354	8,362	352,155
22	8,369	8,382	343,793
23	8,394	8,397	335,411
24	8,400	8,394	327,014
25	8,388	8,383	318,620
26	8,378	8,369	310,237
27	8,359	8,350	301,868

Technical Appendix

1. In Section II above an attempt has been made to describe the method of compiling a working-life table in non-technical terms as far as it is possible to do so. The technical appendix which follows gives a more detailed explanation of both the methods and the sources of information used, together with some examples of the way in which various probabilities can be computed from the tables.

2. Full life tables are prepared for Great Britain at intervals by the Government Actuary, and such a table for 1930–32 has been used as the basis for Table 2. Abridged life tables based on a moving three year total of deaths and population are prepared annually by the General Register Office. A table for 1952–54, extended by the Government Actuary to give figures for individual years of age, has been used for Table 1 as being sufficiently close to 1955.* The description in the following paragraphs refers for convenience to the 1955 table (Table 1), but the method is also applicable to the table for 1931.

3. The basic figure in a life table is a hypothetical group of 10,000 persons born at the same time. This is followed by an estimate of the number likely to survive at the first birthday on the assumption that the group is subject to the same risk of death in the first year of age that was shown by the actual "vital statistics" during the period adopted as the basis of the computation, together with the further assumption that there is no migration into or out of the hypothetical community. A similar estimate is made of the number surviving at the second and each subsequent birthday until the last of the group finally disappears at 101 years of age or thereabouts. The Column of figures thus produced (column 3) is represented by the symbol l_x.

4. The main purpose of a life table, in the present connexion, is to provide an estimate of the average number of years of life remaining to each group of persons represented by the symbol l_x. For this purpose it is necessary first of all to estimate the aggregate total number of man-years that all persons in that group will live. In order to do this it is usually assumed that deaths between ages x and $x + 1$ are spread evenly over the intervening year and that the number of man-years lived during that interval by the group of l_x persons alive at the beginning of it can be taken to be equal to the average of that number and the smaller number (l_{x+1}) alive at the end of it. In the same way it can be taken that the number of man-years lived between age $x + 1$ and age $x + 2$ by those who survive at age $x + 1$ will be the average of l_{x+1} and l_{x+2}. This process can be continued until the last survivor dies, and the total number of man-years remaining to any group l_x after age x will be the sum of the averages of consecutive pairs of figures in the l_x column from that age onwards.

The figures obtained by this process of averaging each consecutive pair of figures l_x and l_{x+1} are designated by the symbol L_x. The figures for 1955 are set out in Column 4 of Table 1. The relationship between l_x and L_x is therefore represented by the equation:

$$L_x = \tfrac{1}{2}\,(l_x + l_{x+1})$$

The sum of the figures L_x for age x and all higher ages is designated by the symbol T_x. Thus,

$$T_x = \sum_{x}^{\infty} L_x$$

5. Since T_x represents the total number of man-years of life remaining for the l_x persons who were alive at the beginning of the period to which it relates, the "average expectation of life" for that group of persons can be obtained by dividing T_x by l_x. The figure thus obtained is designated by the symbol $\mathring{e}_x$, so that

$$\mathring{e}_x = \frac{T_x}{l_x}$$

The figures T_x and $\mathring{e}_x$ for 1955 are shown in Columns 5 and 6 of Table I. It is important to bear in mind that $\mathring{e}_x$ must always be interpreted in relation to the assumptions underlying the whole table. In other words, it is the average number of years of life remaining to persons of age x on the assumption that they will be subject throughout their lives to the mortality rates that were actually experienced by the population of the country during the period that was adopted to provide the basis of the computation. In no sense do the figures represent an attempt to forecast the actual course of events in years to come.

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* As a minor consequence of the individual interpolations, the values of $\mathring{e}_x$ at certain points differ slightly from the values originally given in the Registrar General's Abridged Life Table for 1952–54.

6. The essential link in the transition from a life table to a working life table is the proportion of the total population that is engaged in gainful occupation at each year of age. For 1955 the requisite material had to be obtained from various sources. Estimates of the total male population in five-year age-groups were obtained from tables published by the Registrars-General, and these were analysed into individual years of age mainly on the basis of the detailed figures derived from the 1951 Census of Population. Estimates of the numbers of male employees in the civil population were available from the annual count of national insurance cards, analysed into individual years of age on the basis of a random sample of 1 per cent. of insured employees. Estimates of the total number of self-employed men were also available, and these were analysed into individual years of age partly on the basis of the one per cent. sample of national insurance records and partly on the basis of the 1951 Census of Population (the latter source had to be relied on, for example, for information about men over 70 years of age, who are not insurable under the national insurance scheme). Detailed age-analyses of the numbers of men in H.M. Forces (at home and abroad) were supplied by the Service Departments. The figures from these various sources were added together to provide an analysis by individual years of age of the total male working population. The figures thus obtained included the total number in civil employment (employers and workers on their own account as well as employees, both full-time and part-time), persons registered as unemployed and those temporarily absent from work owing to sickness, holidays or other causes, members of the Armed Forces and Women's Auxiliary Services (both at home and abroad) and persons released from the Forces who had not yet taken up employment. They exclude unpaid family workers.* Each of these figures was then expressed as a percentage of the estimated total male population of the same age, thus producing a series of figures showing the proportion that the working population represented of the total population.

7. The "occupied" proportions obtained by the method described in the preceding paragraph were then adjusted for two reasons. Firstly, although the majority of boys leave school at the age of fifteen and enter employment more or less immediately, a number remain at school beyond that age and some of them continue their education at Universities, etc., eventually entering employment at the end of their course of higher education. For this reason the actual proportion occupied in 1955 showed a gradual increase from age 15 onwards till it reached a maximum of 99·7 per cent. at age 28. The lower proportions at the younger ages were in effect due to the fact that entry into employment had been deferred until training for that employment had been completed, and it would be reasonable to assume that the percentages at those ages, if account were taken of the numbers in training (i.e. continuing their education), would be at least equal to the figure of 99·7 per cent. at age 28. It is probable that the proportions at those ages would in fact be very slightly higher than 99·7 per cent., but since the wastage through causes other than death at those ages must be very small it has been assumed that the percentage on that basis at each year of age between 15 and 27 was 99·7. In order to avoid the complication of separately treating new entry into the labour force (which would be of significance only at the initial ages) the figure of 99·7 per cent. has been used for every one of the years of age in question for the purpose of the computation of the expectation of working life as described in the following paragraphs. This procedure does in fact produce the best estimate of the expectation of working life for those *actually working* at age 15, 16, etc. It should be noted that one result of the adoption of the constant percentage for each of the years in question is that there are no figures for those years in Col. 15 of Table 1 (losses from the working population through causes other than death), but it is assumed that such losses as do take place at those ages are too small to be of any significance.

8. The second adjustment was due to the possibility that the basic material may have been imperfect for various reasons. For 1955 the official estimates of the total population were in five year groups only and the figures for individual years of age, obtained by interpolation, must have been subject to error. The age analysis of the working population was obtained mainly on the basis of a 1 per cent. sample of employees insured under the National Insurance Scheme, and figures obtained in that way must also be subject to margins of error in varying degrees. The original series of percentages obtained by relating these two series to each other showed fluctuations above and below a line of diminishing trend and it is probable that these fluctuations were due to some extent to the possible errors in the basic figures. It

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* The figures for 1931 were taken from the tables of the Population Census of that year. Their content is very close to that of the 1955 figures as described above; the main differences were that the 1931 figures included a number (probably small) of unpaid family workers and also a number of sick persons who were also out of a situation but were not registered for work.

was thought that the most reasonable assumption to make was that the true series would show a continuing downward trend from year to year, and the figures as computed were therefore adjusted to produce a series of that kind.

9. Percentages computed in the way described in para. 7 relate to the number of occupied persons who have reached their x^{th} birthday but have not reached their $(x + 1)^{th}$. For the purpose of the computation of the table of working life, however, it is necessary to obtain percentages which can be related to the numbers at their x^{th} birthday, i.e. l_x (Column 3 of Table 1). For all ages up to 50, the proportions occupied showed such small annual decrements that the percentages as computed and adjusted were adopted as suitable for application to l_x on the same line. For higher ages the percentage for application to l_x was interpolated between the computed figure for age x and the figure for age $x - 1$. The interpolation for age 65 required special consideration. In the series of occupied percentages computed by the method described in para. 7 the figure for age 65 was considerably lower than the figure for age 64, the two ages 64 and 65 meaning "aged 64 and under 65" and "aged 65 and under 66", respectively. This reduction is due to the fact that considerable numbers of persons take their pensions under the National Insurance Act and retire from their employment sometime in the year following their 65^{th} birthday. It is to be assumed therefore that in a series of figures of the l_x type (which relate to exact years of age) the proportion occupied at exact age 65 is not much lower than the figure for age 64 and that the big reduction is in the figure for exact age 66 compared with that for age 65. In the table for 1955 the occupied proportion for exact age 65 has therefore been taken at 87·5 per cent., compared with 90·0 per cent. for age 64, and the effect of taking retirement pensions after reaching the age of 65 is shown in the reduction to 60·0 per cent. at age 66.

The series of figures thus established is shown in Column 2 of Table 1 under the symbol w_x.

10. The w_x figures have been used as multipliers to apply to the l_x figures in Column 3 in order to establish a new column of figures under the symbol l_x^w (Column 7), which can be defined as the number of persons in the working population at each exact year of age out of the original group of 10,000.

11. Having established the column of figures l_x^w it is possible to compute the average expectation of working life by a similar procedure to that which was used to compute the average expectation of life from the column of figures l_x. The intermediate figures L_x^w (Column 8) for all years of age with the exception of 65 are obtained on the basis of the equation

$$L_x^w = \tfrac{1}{2}(l_x^w + l_{x+1}^w).$$

For age 65 a figure obtained by means of the foregoing formula would be considerably higher than the figure that would be obtained by multiplying L_x by the original w_x referred to in para. 9. This is no doubt due to the probability that a high proportion of the large number of retirements between the 65^{th} and 66^{th} birthdays take place soon after the 65^{th} birthday, so that the average number in the working population between these two birthdays is lower than the average of the numbers at the two exact birthdays.[*] It was therefore decided to adopt a figure for L_x^w for age 65 which would have a similar relationship to the L_x^w figures for 64 and 66 as the original w_x figure (based on the actual population) bore to the corresponding figures for 64 and 66.

12. The figures L_x^w for each age and all higher ages are then accumulated and set out in Column 9 under the symbol T_x^w. Finally each figure T_x^w is divided by the figure l_x^w on the same line, the result being the average expectation of working life for occupied persons at exact age x. These are set out in Column 10 under the symbol $\mathring{e}_x^w$. These figures are subject to the same reservations that were mentioned in para. 5 in relation to the figures of the expectation of life ($\mathring{e}_x$), i.e., they merely indicate what will happen if conditions remain the same as in the period adopted as the basis of the computation.

13. The difference between two consecutive figures in the l_x^w column represents the number lost out of the working population during the intervening year. The differences between each pair (i.e. $l_x^w - l_{x+1}^w$) are set out in Column 11 under the symbol s_x^w. These figures consist partly of deaths and partly of losses out of the working population from other causes (retirement, infirmity, etc.). Each figure s_x^w can be analysed into these two component parts on the assumption that the death rate in the working population of any given age is the same as the death rate in the total population of the same age.[†] The Central Death Rate for the total population is computed by expressing the number of deaths between two specific ages as a rate per thousand of the average number in the

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[*] Evidence of this concentration of retirements soon after the 65th birthday is provided by Table 6 of the *Report of the Ministry of Pensions and National Insurance for the year 1957*. (Cmnd. 493).

[†] For all ages up to 65 the margin of error in this assumption is probably very small since the working population is a very large part of the total population. With the progressive reduction in the ratio of the working population to the total population at higher ages the possibility of error is naturally somewhat greater.

population between those ages. The number of deaths is $l_x - l_{x+1}$ and the average number in the population between the two specific ages is L_x. The Central Death Rate is represented by the symbol m_x, so that

$$m_x = \frac{l_x - l_{x+1}}{L_x}$$

This is the Central Death Rate for the population represented by l_x, and since it is assumed that the same rate is applicable to the corresponding working population l_x^w, the actual number of deaths in a year from that working population (excluding deaths after retirement) can be computed by multiplying the average number in the working population between two consecutive specific ages (i.e., L_x^w) by m_x. The number of deaths from the working population is represented by d_x^w, so that

$$d_x^w = L_x^w \times m_x$$

The value of m_x for each year of age can be computed from the figures in Columns 3 and 4 of Table 1, and the values of L_x^w are available in Column 8. From these figures the value of d_x^w was obtained for each year of age and they are set out in Column 13. The numbers of losses from the working population through causes other than death were then obtained by subtracting each figure d_x^w from the corresponding figure s_x^w (Column 11) and the figures are set out in Column 15 under the symbol r_x^w.

14. The final step was to express these losses from the working population (s_x^w, d_x^w and r_x^w) as rates per thousand of the working population. It was considered that the most satisfactory basis for the computation was the average number "at risk" during the year, i.e. L_x^w. A rate of loss computed on this basis is a Central Loss Rate for the working population, and it has the advantage of being capable of being applied to actual population figures of a Census type. The rates obtained in this way are set out in Columns 12, 14 and 16 under the symbols m_x^s, m_x^d and m_x^r, so that

$$m_x^s = \frac{s_x^w}{L_x^w} \quad \text{(central loss rate)}$$

$$m_x^d = \frac{d_x^w}{L_x^w} \quad \text{(central rate of mortality)}$$

and

$$m_x^r = \frac{r_x^{w}{}^*}{L_x^w} \quad \text{(central rate of retirement)}$$

also

$$m_x^s = m_x^d + m_x^r$$

PROBABILITIES OF REMAINING IN OR LEAVING THE WORKING POPULATION

15. The principal probabilities that can be computed from the information contained in Tables 1 and 2 are given below in algebraic form, together with numerical examples taken from Table 1.

(1) The probability that a man in the working population aged x will still be in the working population in n years' time is

$$\frac{l_{x+n}^w}{l_x^w}$$

For example, the probability that a man aged 30 will still be in the working population in 35 years' time (i.e. at age 65) is

$$\frac{l_{65}^w}{l_{30}^w} = \frac{5{,}849}{9{,}390} = \cdot 623, \text{ or } 62{\cdot}3 \text{ per cent.}$$

(2) The probability that a man in the working population aged x will have left the working population in n years' time is

$$\frac{l_x^w - l_{x+n}^w}{l_x^w}$$

For example, the probability that a man aged 30 will have left the working population in 35 years' time (i.e. before reaching age 65) is

$$\frac{l_{30}^w - l_{65}^w}{l_{30}^w} = \frac{9{,}390 - 5{,}849}{9{,}390} = \frac{3{,}541}{9{,}390}$$

$$= 0{\cdot}377 = 37{\cdot}7 \text{ per cent.}$$

(3) The probability that a man in the working population aged x will have left the working population in n years' time owing to death is

$$\frac{d_x^w + d_{x+1}^w + \ldots + d_{x+n-1}^w}{l_x^w}$$

For example, the probability that a man aged 30 in the working population will have left the working population in 35 years' time (i.e. before reaching age 65) owing to death is

$$\frac{d_{30}^w + d_{31}^w + \ldots d_{64}^w}{l_{30}^w}$$

$$= \frac{12 + 13 + \ldots + 204}{9{,}390}$$

$$= \frac{2{,}613}{9{,}390} = 0{\cdot}278 = 27{\cdot}8 \text{ per cent.}$$

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[*] m_x^r could also be computed directly from the w_x figures in Col 2. The w_x series represents the reduction year by year in a working population where the only source of decrement is "retirement", i.e., where the effect of death has been removed. The Central Retirement Rate on this basis would be

$$\frac{w_x - w_{x+1}}{W_x} \text{ where } W_x = \frac{w_x + w_{x+1}}{2}$$

For the reason set out in para. 9 above, however, this procedure cannot be used to obtain m_x^r for age 65.

(4) The probability that a man in the working population aged x will have left the working population in n years' time from a cause other than death is

$$\frac{r^w_x + r^w_{x+1} + \dots + r^w_{x+n-1}}{l^w_x}$$

For example, the probability that a man aged 30 in the working population will have left the working population in 35 years' time (i.e. before reaching age 65) from a cause other than death is

$$\frac{r^w_{30} + r^w_{31} + \dots + r^w_{64}}{l^w_{30}}$$

$$= \frac{10 + 9 + \dots + 170}{9{,}390}$$

$$= \frac{928}{9{,}390} = 0 \cdot 099 = 9 \cdot 9 \text{ per cent.}$$

(5) The probability that a man in the working population aged x will still be in the working population at age $x + n$ and will have left the working population in m years' time after age $x + n$ owing to death is

$$\frac{l^w_{x+n}}{l^w_x} \times \left(\frac{d^w_{x+n} + d^w_{x+n+1} + \dots + d^w_{x+n+m-1}}{l^w_{x+n}}\right)$$

For example, the probability that a man aged 30 in the working population will still be in the working population at age 65 and will have left the working population in 5 years' time after age 65 owing to death is

$$\frac{l^w_{65}}{l^w_{30}} \times \left(\frac{d^w_{65} + d^w_{66} + \dots + d^w_{69}}{l^w_{65}}\right)$$

$$= \frac{5{,}849}{9{,}390} \times \left(\frac{153 + 145 + \dots + 120}{5{,}849}\right)$$

$$= \frac{682}{9{,}390} = 0 \cdot 073 = 7 \cdot 3 \text{ per cent.}$$

(6) The probability that a man in the working population aged x will still be in the working population at age $x + n$ and will then have left the working population in m years' time after age $x + n$ from a cause other than death is

$$\frac{l^w_{x+n}}{l^w_x} \times \left(\frac{r^w_{x+n} + r^w_{x+n+1} + \dots + r^w_{x+n+m-1}}{l^w_{x+n}}\right)$$

For example, the probability that a man aged 30 in the working population will still be in the working population at age 65 and will have left the working population in 5 years' time after age 65 from a cause other than death is

$$\frac{l^w_{65}}{l^w_{30}} \times \left(\frac{r^w_{65} + r^w_{66} + \dots + r^w_{69}}{l^w_{65}}\right)$$

$$= \frac{5{,}849}{9{,}390} \times \left(\frac{1{,}831 + 378 + \dots + 219}{5{,}849}\right)$$

$$= \frac{3{,}021}{9{,}390} = 0 \cdot 322 = 32 \cdot 2 \text{ per cent.}$$

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